

Parasitic Helminths and Arthropods of Greater Shearwaters (*Puffinus gravis*) from Florida

GARRY W. FOSTER,¹ JOHN M. KINSELLA,¹ ROGER D. PRICE,²
JAMES W. MERTINS,³ AND DONALD J. FORRESTER¹

¹ Department of Pathobiology, College of Veterinary Medicine,
University of Florida,
Gainesville, Florida 32611,

² Department of Entomology, University of Minnesota, St. Paul, Minnesota 55108, and

³ U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Veterinary Services,
National Veterinary Services Laboratories, P.O. Box 844, Ames, Iowa 50010

ABSTRACT: Fifteen greater shearwaters (*Puffinus gravis*) collected during June 1993 from the east coast of Florida were examined for parasites. Twenty-five species were identified and included 5 nematodes, 4 cestodes, 9 mites, 6 chewing lice, and 1 tick. All birds examined were infected with at least 4 species of helminths (mean 5.2, range 4–7 species). All are known from greater shearwaters except *Stegophorus diomedae*, *Stegophorus stellae-polaris*, and *Tetrabothrius minor*. The most common helminths were the cestodes *Tetrabothrius filiformis* and *Tetrabothrius laccocephalus* and the nematode *Stegophorus diomedae*, which occurred in prevalences of 100%, 93%, and 93%, respectively. All 15 birds were infested with chewing lice, but 4 birds were free of mites. Each bird was infested by at least 3 species of parasitic arthropods (mean 6.8, range 3–12 species). The most common arthropods were 2 chewing lice, *Austromenopon paululum* and *Halipeurus gravis*, both of which occurred on 100% of the birds. The bird tick, *Ixodes auritulus*, is reported for the first time from the east coast of the United States.

KEY WORDS: greater shearwater, *Puffinus gravis*, cestodes, nematodes, chewing lice, mites, ticks, survey, prevalences, Florida.

Greater shearwaters, *Puffinus gravis* (O'Reilly), are large, fairly common pelagic Atlantic seabirds in the order Procellariiformes. Following the breeding season in the south Atlantic, they migrate over the western Atlantic from May through June, after which they become widely distributed in the north Atlantic. Greater shearwaters irregularly frequent the east coast and, to a much lesser extent, the west coast of Florida in late spring and summer before they return to their breeding grounds in the fall. Highly gregarious the year round, greater shearwaters often occur in flocks of 50–100 or more and, when off the U.S. coast, remain well offshore (Stevenson and Anderson 1994). Parasitic helminths and arthropods have been reported from greater shearwaters in the north Atlantic by Bourgeois and Threlfall (1979) and Mobley and Miller (1981), and from their breeding grounds in the south Atlantic by Hoberg and Ryan (1989). Herein we report the parasitic helminths and arthropods collected from a sample of greater shearwaters from the Atlantic coast of Florida.

Methods

Fifteen greater shearwaters (5 males, 10 females) were collected from the Atlantic Ocean adjacent to Brevard

(*N* = 6) and Martin (*N* = 9) counties on the east coast of Florida. These birds were part of a die-off that occurred in June 1993 and involved approximately 80 seabirds, most of which were greater shearwaters, but also included a few Cory's shearwaters (*Calonectris diomedea* (Scopoli)) and Leach's storm-petrels (*Oceanodroma leucorhoa* (Vieillot)). Most of the birds collected had washed up on shore following a period of high winds and heavy surf, and were alive, but died shortly after being transported to rehabilitation centers and before being treated. All birds examined were severely emaciated, and the cause of death seemed to be related to starvation (M. G. Spalding, pers. comm.). Three birds were placed in plastic bags, put on ice, and examined at necropsy within 24 hr. The other 12 birds were put in individual plastic bags and frozen until examination. Techniques for recovering, fixing, staining, and examining helminths followed Kinsella and Forrester (1972) and Forrester et al. (1974). Ectoparasites were collected by washing each bird in a bucket with soapy water, then rinsing it with a pressurized water spray. The soapy water and rinse water were poured through a 100-mesh screen. With the aid of a dissecting microscope, ectoparasites were removed and placed in vials containing 70% alcohol with glycerin. Representative voucher specimens have been deposited as follows: helminths in the U.S. National Parasite Collection (Beltsville, Maryland), mites in the Parasitology Collection of the USDA National Veterinary Services Laboratories (Ames, Iowa), chewing lice in the arthropod collections at the University of Minnesota and the K. C. Emerson Collection at Oklahoma State University, and the tick in the U.S. National Tick

Table 1. Prevalence and intensity of helminths infecting 15 greater shearwaters from Florida.

Helminth	USNPC accession no.	Number of birds		Intensity	
		Infected	%	Mean	Range
Cestoda					
<i>Tetrabothrius diomedea</i> Fuhrmann, 1900 (5)*	84034	8	53	1	1-2
<i>Tetrabothrius filiformis</i> Nybelin, 1916 (5)	84033	15	100	99	6-305
<i>Tetrabothrius laccocephalus</i> Spätlich, 1909 (5)	84032	14	93	7	1-22
<i>Tetrabothrius minor</i> (Lönnberg, 1893)† (5)	84186	1	7	3	—
Nematoda					
<i>Seurattia shipleyi</i> (Stossich, 1900) (1)	83289	9	60	4	1-8
<i>Stegophorus diomedae</i> (Johnson and Mawson, 1942)† (3, 4)	83290	14	93	4	1-12
<i>Stegophorus stellae-polaris</i> (Parona, 1901)† (4)	84035	3	20	1	1-2
<i>Contracaecum</i> sp. (larvae) (2)	—	12	80	9	1-67
Larval spirurids (1, 4)	—	3	20	5	1-13

* Numbers in parentheses indicate locations in host: (1) stomach, (2) stomach wall, (3) gizzard, (4) koilon lining, (5) small intestine.

† New host record.

Collection (Georgia Southern University, Statesboro, Georgia).

Results and Discussion

Helminths

Nine species of helminths were collected from the 15 greater shearwaters, none of which was free of helminths. This included 4 species of cestodes and 5 species of nematodes. All are known from greater shearwaters except *Stegophorus diomedae*, *Stegophorus stellae-polaris*, and *Tetrabothrius minor*. Sites, prevalences, and intensities of each species are given in Table 1. All birds examined were infected with at least 4 species of helminths (mean 5.2, range 4-7 species). Multiple infections were as follows: 5 birds had 4 species of helminths, 3 had 5 species, 5 had 6 species, and 2 had 7 species. A total of 1,805 helminths was collected.

Three of the 4 species of *Tetrabothrius* have been collected also from *P. gravis* on its breeding grounds in the south Atlantic. Although prevalences of *Tetrabothrius* spp. in Florida were very similar to those reported at Gough Island by Hoberg and Ryan (1989), intensities were much lower. The mean intensities for cestodes were 108 in Florida and 1,157 at Gough Island, supporting the conclusion of Hoberg and Ryan that

Tetrabothrius spp. are acquired by shearwaters primarily on the breeding grounds and lost, without replacement, during migration and wintering. However, the lower intensities we report may also be due to the emaciated condition of the birds collected and the physiologic changes that take place during starvation. Bourgeois and Threlfall (1979) reported the range of *Tetrabothrius* spp. to be "1-several hundred," but did not give the mean intensity, so we cannot compare our results with theirs.

Nematodes of the genera *Seurattia* and *Stegophorus* have been reported from a variety of seabirds, including fulmars, petrels, and albatrosses (Wehr, 1934; Johnston and Mawson, 1942; Rodrigues and Mendonca, 1967), and seem to exhibit ecological rather than host specificity. *Seurattia shipleyi* now has been reported from *P. gravis* throughout its range in the Atlantic (Bourgeois and Threlfall, 1979; Hoberg and Ryan, 1989). *Stegophorus diomedae* and *S. stellae-polaris* have not been reported from greater shearwaters, although Bourgeois and Threlfall (1979) reported an unidentified species of *Stegophorus* from this host in the north Atlantic.

Larval *Contracaecum* have been reported also in greater shearwaters in all parts of their range, but appear to be incapable of developing to the

Table 2. Prevalence of parasitic arthropods infesting 15 greater shearwaters from Florida.

Species of arthropod	Number of birds		Total number collected
	Infected	%	
Feather mites			
<i>Zachvatkinia puffini</i> (Buchholtz, 1869)	11	73	105
<i>Brephosceles puffini</i> Peterson, 1971	11	73	85
<i>Ingrassia</i> sp.	8	53	104
<i>Microspalax</i> sp.	3	20	38
<i>Opetiopoda</i> sp.	1	7	2
<i>Alloptoides</i> sp.	1	7	1
Skin mites			
<i>Dermation</i> (<i>Neodermation</i>) sp.	3	20	4
<i>Harpyrhynchus</i> sp.	1	7	2
Nasal mites			
Mesostigmata: Rhinonyssidae	1	7	3
Chewing lice			
<i>Austromenopon paululum</i> (Kellogg and Chapman, 1899)	15	100	751
<i>Halipeurus gravis</i> Timmermann, 1961	15	100	355
<i>Trabeculus hexakon</i> (Waterston, 1914)	14	93	101
<i>Naubates harrisoni</i> Bedford, 1930	12	80	53
<i>Saemundssonina peusi</i> (Eichler, 1949)	3	20	4
<i>Ancistrana vagelli</i> (J. C. Fabricius, 1787)	2	13	6
Ticks			
<i>Ixodes auritulus</i> Neumann, 1904 (RML# 121491)*	1	7	1

* U.S. National Tick Collection accession number.

adult stage in this host. Many of these larvae were encysted within the wall of the ventriculus and appeared to have been killed by the host's immune system.

Intensities of helminths were low in comparison with those reported by Hoberg and Ryan (1989), and appeared to have no causal relationship in the die-off of these birds on the Florida coast.

Arthropods

Sixteen species of parasitic arthropods were collected, including 6 species of chewing lice, 6 feather mites, 2 skin mites, 1 nasal mite, and 1 tick. All are known from greater shearwaters except 3 of the feather mites, the skin mites, the nasal mite, and the tick. Prevalences and total numbers of each species collected are presented in Table 2. All 15 birds were infested with chewing lice, but 4 birds were free of mites. Each bird was infested by at least 3 species of parasitic arthropods (mean 6.8, range 3–12 species). Multiple infestations were as follows: 1 bird had 3 species of arthropods, 3 had 4 species, 1 had 6 species, 6 had 7 species, 3 had 9 species, and 1 had 12 species. A total of 1,615 arthropods was

collected and identified, but intensities could not be calculated because quantitative techniques were not used to obtain every parasitic arthropod from each host as they were for the parasitic helminths.

The 6 species of chewing lice taken from greater shearwaters represent all but 1 of the 7 known louse taxa recognized at this time from this host. *Austromenopon paululum*, by far the most common louse collected in this study, is distributed widely among the species of *Puffinus*, having been identified from 13 species of this host genus. Two additional species of *Austromenopon* do occur on other *Puffinus*, but in a very restricted fashion, being reported from only 1 and 3 species of *Puffinus*, respectively. Contrasted to this, *Halipeurus gravis*, the second most common louse we collected, is limited in its distribution to the greater shearwater. There apparently is a higher degree of host/louse-specificity within this louse genus, as 10 other species of *Halipeurus* are recognized on *Puffinus*, including each of 5 from a single host species, 4 from 2–3 host species, and 1 from 5 host species. Over 30 of the 50+ species of *Austromenopon* occur on the Charadriiformes, with a single species each on the Pelecaniformes

and Ciconiiformes; the almost 30 species of *Halipeurus* are found only on members of the Procellariiformes, with 25 of them on members of the family Procellariidae.

The 6 species of *Trabeculus* and the 8 species of *Naubates* are restricted in their distribution to hosts within the Procellariidae. *Trabeculus hexakon* is found not only on 5 species of *Puffinus*, in addition to *P. gravis*, but also on at least 13 host species in other genera. *Naubates harrisoni* occurs only on *Puffinus*, being known from 10 host species including *P. gravis*.

Saemundssonina is a very large genus, including over 85 species and a complexity of numerous named subspecies, many of the latter of dubious validity. The genus is distributed on 4 bird orders in addition to the Procellariiformes. There are 7 species of *Saemundssonina* on hosts within *Puffinus*, with *S. peusi* also known from Cory's shearwater (*Calonectris diomedea*). Only a single species of *Ancistronea*, *A. vagelli*, is known, which is found on more than 20 species of Procellariidae as well as on several species of Hydrobatidae. With more collecting, this species will probably prove to have a much broader distribution on hosts of these families.

In addition to the 6 genera and species of chewing lice discussed above from the greater shearwaters, Bourgeois and Threlfall (1979) reported *H. diversus* as an additional species *Halipeurus*, along with a *Docophoroides* sp. Both of these represent valid taxa from the Procellariidae. However, the first is most likely the result of an instance of natural straggling, as it is not a regular normal inhabitant of the greater shearwater (R. L. Palma, pers. comm.). The *Docophoroides* sp., given as "1 F?" by Bourgeois and Threlfall (1979: Table 1), represents a misidentification that has been confirmed by the late K. C. Emerson; the slide actually carried only an immature homopteran and half of a pseudoscorpion together (R. L. Palma, pers. comm.).

Interestingly, Bourgeois and Threlfall (1979) found *T. hexakon* the most abundant louse (mean/host = 25) and *A. paululum* among the least common (mean/host = 2). While the former was third most common in our study, the latter was by far the most common. These differences are most likely a function of the collecting techniques utilized, although they might possibly indicate some meaningful difference in louse fauna composition.

Seven of the 9 mite taxa we collected from greater shearwaters (Table 2) are probably true

associates of this bird host. It seems likely that the other 2 mites were present on these birds as contaminants from the environment or other co-existing bird populations. In the latter group are a single female *Alloptoides* sp. (family Alloptidae) and 2 female *Harpyrhynchus* sp. (family Harpyrhynchidae) from 1 bird. The known species of *Alloptoides* are feather mites associated with ducks, but this genus is poorly understood, and species cannot be identified without male specimens. Harpyrhynchids are poorly known prostigmatid bird parasites usually associated with the host's skin. Most harpyrhynchids collected to date have come from evolutionarily advanced bird orders, with very few records from either less advanced or aquatic birds (Moss and Wojcik, 1977; Moss, 1979). Mites in this family are thought to be very host-specific. We know of no other collections from Procellariiformes.

The 3 most common feather mites collected were all present as males, females, and nymphs. The most common mite on *P. gravis* was *Zachvatkinia puffini* (family Avenzoariidae). This species is known from 4 genera in the family Procellariidae, including several *Puffinus* spp. besides *P. gravis* (Mironov, 1991). *Brephosceles puffini* (family Alloptidae) was present on as many birds as *Z. puffini*, but in slightly smaller numbers. Members of this genus are associated typically with a variety of aquatic birds (Peterson, 1971), and *Puffinus* spp. are favored. The greater shearwater is a known host of at least 2 species of *Brephosceles*, including *B. puffini*. *Ingrassia* sp. (family Xolalgidae) were as numerous as *Z. puffini*, but they occurred on fewer birds. The approximately 25 species in this genus are described from shorebirds, sea birds, grebes, and ducks (Gaud and Atyeo, 1981), but the descriptions and taxonomy of the few species from Procellariiformes are obscure and confusing. We find no previous records of *Ingrassia* from greater shearwaters, and the present specimens may represent a new, undescribed species.

Microspalax sp. (family Alloptidae) was the only other mite collected in large numbers, although only 1 male was taken among 37 females from 3 birds. *Microspalax* is the only genus in the alloptid subfamily Microspalacinae, and the 10 currently recognized species are all associated with various shearwaters and storm petrels (Aty eo and Gaud, 1991). Although specimens that are probably conspecific with our *Microspalax* mites were collected from greater shearwaters as early as 1883 (Dubinin, 1949), there is much uncer-

tainty about the taxonomic and host associations within the genus, and the mite from greater shearwaters remains unnamed and undescribed (Atyeo and Gaud, 1991).

We collected only 1 male and 1 female *Opetiopoda* sp. (family Xolalgidae) on 1 greater shearwater. At present, the only described species of the genus is *O. anadermura* Gaud & Atyeo from the wedge-tailed shearwater (*P. pacificus* (Gmelin)) (Gaud and Atyeo, 1981). Our specimens represent a second, undescribed species.

There were 4 female *Dermation* sp. (family Dermationidae) on 3 of our birds. All were similar and seem to belong in the subgenus *Neoderma*, a group until now reported only on the skin of ducks (Fain, 1965). We are unaware of any previous records of *Dermation* from Procellariiformes, and the present specimens are probably a new species.

One male and 2 female mesostigmatid nasal mites in the family Rhinonyssidae were collected from 1 greater shearwater. There do not seem to be any previous records of rhinonyssids from any Procellariiformes (Maa and Kuo, 1965; Domrow, 1969; Pence, 1975; Spicer, 1987), and our mites probably represent an undescribed taxon.

The identification of a nymphal *Ixodes auritulus* is the first record of the occurrence of this bird tick from the east coast of the United States. *Ixodes auritulus* has a wide geographic distribution in the Southern Hemisphere, which is summarized by Arthur (1960). In the Northern Hemisphere, *I. auritulus* has been reported mainly from Central and North America. In North America this tick has been, for the most part, reported from the west coast of the United States and Canada. Its distribution in the United States includes Alaska, California, Colorado, Oregon, and Washington (Keirans and Clifford, 1978).

Acknowledgments

We are grateful to J. R. Lichtenfels for allowing us to borrow helminth specimens from the U.S. National Parasite Collection for comparison. We thank J. E. Keirans for identifying the nymphal tick, and E. P. Hoberg for confirming the *Tetrabothrius* identifications. We also thank R. L. Palma for his comments on the Mallophaga, and M. G. Spalding for her comments on the condition of the birds. We also thank E. C. Greiner and M. D. Young, who reviewed an early draft of the manuscript and offered some useful suggestions for its improvement. This research was

supported in part by a contract from the Florida Game and Fresh Water Fish Commission and is a contribution of Federal Aid to Wildlife Restoration, Florida Pittman-Robertson Project W-41. This is Florida Agricultural Experiment Stations Journal Series No. R-04224.

Literature Cited

- Arthur, D. R. 1960. A review of some ticks (Acarina: Ixodidae) of sea birds. Part II. The taxonomic problems associated with the *Ixodes auritulus-percavatus* group of species. *Parasitology* 50:199–226.
- Atyeo, W. T., and J. Gaud. 1991. Microspalacinae, a new subfamily of the feather mite family Allopodidae Gaud (Acarina, Analgoidea). *Folia Parasitologica* 38:327–343.
- Bourgeois, C. E., and W. Threlfall. 1979. Parasites of the greater shearwater (*Puffinus gravis*) from Newfoundland, Canada. *Canadian Journal of Zoology* 57:1355–1357.
- Domrow, R. 1969. The nasal mites of Queensland birds (Acari: Dermanyssidae, Erythetidae, and Epidermoptidae). *Proceedings of the Linnean Society of New South Wales* 93:297–426.
- Dubinin, V. B. 1949. [Feather mite fauna of birds of the order Procellariiformes and its features.] *Parazitologicheskii Sbornik* 11:201–228. (In Russian.)
- Fain, A. 1965. A review of the family Epidermoptidae Trouessart parasitic on the skin of birds (Acarina: Sarcopitiformes). *Verhandelingen van de Koninklijke vlaamse Academie voor wetenschappen Lettern en Schone kunsten van Belgie. Klasse der wetenschappen* 27:(I)1–176, (II)1–144.
- Forrester, D. J., A. O. Bush, L. E. Williams, Jr., and D. J. Weiner. 1974. Parasites of greater sandhill cranes (*Grus canadensis tabida*) on their wintering grounds in Florida. *Proceedings of the Helminthological Society of Washington* 41:55–59.
- Gaud, J., and W. T. Atyeo. 1981. La famille Xolalgidae, Dubinin, nouveau statut (Sarcopitiformes Plumicoles, Analgoidea) I. Sous-famille Ingrassinae, n. sub. fam. *Acarologia* 22:63–79.
- Hoberg, E. P., and P. G. Ryan. 1989. Ecology of helminth parasitism in *Puffinus gravis* (Procellariiformes) on the breeding grounds at Gough Island. *Canadian Journal of Zoology* 67:220–225.
- Johnston, T. H., and P. M. Mawson. 1942. Nematodes from Australian albatrosses and petrels. *Transactions of the Royal Society of South Australia* 66:66–70.
- Keirans, J. E., and C. M. Clifford. 1978. The genus *Ixodes* in the United States: a scanning electron microscope study and key to the adults. *Journal of Medical Entomology* 2(supplement):1–149.
- Kinsella, J. M., and D. J. Forrester. 1972. Helminths of the Florida duck, *Anas platyrhynchos fulvigula*. *Proceedings of the Helminthological Society of Washington* 39:173–176.
- Maa, T. C., and J. S. Kuo. 1965. A field survey of arthropod parasites of birds in Taiwan. *Journal of Medical Entomology* 1:395–401.
- Mironov, S. V. 1991. The feather mites of the family Avenzoariidae, their classification and peculiari-

- ties of their host distributions. Pages 183–192 in F. Dusbábek and V. Bukva, eds. *Modern Acarology*. Vol. 2. Academia, Prague. 461 pp.
- Mobley, R. W., and G. C. Miller.** 1981. Helminths of some seabirds from North Carolina. *Brimleyana* 7:61–68.
- Moss, W. W.** 1979. Patterns of host-specificity and co-evolution in the Harpyrhynchidae. Pages 379–384 in J. G. Rodriguez, ed. *Recent Advances in Acarology*. Vol. II. Academic Press, New York. 569 pp.
- Moss, W. W., and J. F. Wojcik.** 1977. Numerical taxonomic studies of the mite family Harpyrhynchidae (Acari: Cheyletoidea): the higher taxa. *Annals of the Entomological Society of America* 71: 247–252.
- Pence, D. B.** 1975. Keys, species and host list, and bibliography for nasal mites of North American birds (Acarina: Rhinonyssinae, Turbinoptinae, Speleognathinae, and Cytoditidae). *Special Publications of the Museum, Texas Tech University* 8:1–148.
- Peterson, P. C.** 1971. A revision of the feather mite genus *Brephosceles* (Proctophyllodidae: Alloptinae). *Bulletin of the University of Nebraska State Museum* 9:89–172.
- Rodrigues, H. O., and J. M. Mendonca.** 1967. Redescricao de *Stegophorus diomedeeae* (Johnston & Mawson, 1942) Johnston & Mawson, 1945 (Nematoda, Spiruroidea). *Memorias do Instituto Oswaldo Cruz* 65:149–157.
- Spicer, G. S.** 1987. Prevalence and host-parasite list of some nasal mites from birds (Acarina: Rhinonyssidae, Speleognathidae). *Journal of Parasitology* 73:259–264.
- Stevenson, H. M., and B. H. Anderson.** 1994. *The Birdlife of Florida*. University Press of Florida, Gainesville. 904 pp.
- Wehr, E. E.** 1934. Descriptions of three bird nematodes, including a new genus and a new species. *Journal of the Washington Academy of Sciences* 24:341–347.